and leaves, in shaded areas where protection is unimportant, or on the ground surface. While it is impossible to spray only the exposed nuts, with proper equipment there may be ways of applying whitewash sprays with less waste of material.

Vertical boom

Spray applications should be geared to covering mainly the periphery of the tree, since this is the area where the nuts are exposed to the sun. Preliminary tests were conducted using a 28 ft vertical boom mounted on the back of an air-carrier sprayer. The upper one-third of the boom was constructed so that it towered at an angle extending over the centers of the trees during the spraying operation. Spray coverage results were undesirable and were seriously hampered by light winds which caused drifting. Increasing the size of nozzles and reducing operating pressures, thereby increasing droplet size might overcome some of these problems. (D-5 and D-8 hollow-cone nozzles were operated at a pressure of around 150 psi in these tests.) This season more tests will be conducted using different types of nozzles and operating pressures.

Airplane application

In preliminary tests conducted last season with a fixed wing aircraft, spray coverage was undesirable in application of less than 100 gallons of water per acre. The most desirable coverage was obtained with applications of 200 gallons of water per acre (not a very economical rate for the grower). Time of day, type of surfactant, and amount of whitewash in the spray may affect spray coverage. In tests planned this season, attempts will be made to reduce the volume of water needed to give adequate spray coverage by airplane.

Air-carrier sprayers, if properly modified and operated, are capable of good whitewash coverage. Vertical booms and hand guns operated under high pressure are also capable of satisfactorily applying the whitewash spray. However, both of these methods require large amounts of material to do an effective job. The question still remains—is there another method that will give good spray coverage with less material and with the least amount of hand labor. More work is planned for this season in attempts to find other methods.

Floyd Perry is Farm Advisor, Butte County; and A. D. Rizzi is Extension Pomologist, University of California Agricultural Extension Service.

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TABLE 1. MEAN NUMBER OF NODULES PER SOYBEAN PLANT (VARIETY WAYNE) AFTER FERTILIZATION WITH AMMONIUM SULFATE AT DIFFERENT RATES AND TIMES, WEST SIDE FIELD STATION, 1968

Time of application	Nitrogen applied lbs/acre	Straw burned	Straw chopped	Treatment average
		Mean number nodules per plant*		
Preplant	0	17.5	15.4	16.5a
	50	5.2	2.2	3.7 b
	100	1.8	6.8	4.3 b
	150	2.2	4.4	3.3 b
Preplant + flowering	0 + 0 = 0	7.9	23.2	15.6
	0 + 50 = 50	7.9	19.0	13.5
	50 + 50 = 100	5.7	9.4	7.6
	100 + 50 = 150	1.5	8.6	5.1
Flowering	0	12.0	24.6	18.3
	50	17.4	21.2	19.3
	100	13.5	21.8	17.7
	150	4.4	15.2	9.8
Timing, average all rates				
No fertilizer		12.5	21.1	16.8a
Preplant		3.1	4.5	3.8 b
Preplant + flowering		5.0	12.3	8.7ab
Flowering		11.8	19.4	15.6ab
Rates, average all times†				
	0	12.5	21.1	16.8A
	50	10.2	14.1	12.2AB
	100	7.0	12.7	9.9 B
	150	2.7	9.4	6.1 B
Average		8.1	14.3	11.2

* Means with the same letter within any group are not significantly different. Small letters and capital letters indicate 5% and 1% levels of probability, respectively. Means in groups without letters are not significantly different.

† Nodulation and rates were negatively associated in a linear manner.

TABLE 2. MEAN YIELD OF SOYBEANS AFTER FERTILIZATION OF PLOTS WITH AMMONIUM SULFATE AT DIFFERENT RATES AND AT DIFFERENT TIMES

Time of application	Nitrogen applied lbs/acre	Straw burned	Straw chopped	Treatment average
		Yield of beans in lbs per acre*		
Preplant	0	1009	1115	1062
	50	938	1080	1009
	100	1122	1069	1096
	150	950	932	941
Preplant + flowering	0 + 0 = 0	962	1070	1016
	0 + 50 = 50	1177	1105	1141
	50 + 50 = 100	1084	1161	1123
	100 + 50 = 150	997	1145	1071
Flowering	0	1037	1180	1109
	50	962	1240	1101
	100	1064	1260	1162
	150	1030	1238	1134
Timing, average all rates				
No fertilizer		1003	1121	1062
Preplant		1003	1027	1015
Preplant + flowering		1086	1137	1112
Flowering		1019	1246	1132
Rates, average all times				
	0	1003	1121	1062
	50	1026	1142	1084
	100	1090	1163	1127
	150	992	1105	1049
Average		1028	1133	1081

* Differences due to timing, or rates of fertilizer application, and burned or chopped barley straw were not significant.

NITROGEN nodulation and yield SOYBEANS

R. M. HOOVER · B. H. BEARD

A complex relationship exists between the soybean plant and symbiotic Rhizobium. The multiplication of the Rhizobium is dependent on the nitrogen fertility of the soil. On the other hand, the soybean plant can apparently use either nitrogen from the soil or that fixed by bacteria. However, a temporary shortage of nitrogen causing chlorosis did not affect yields in this study. When nitrogen became available later in the season the soybean plant was able to attain the same yield potential.

SOYBEANS SOWN IN BARLEY stubble at the West Side Field Station in 1967 were yellow-green in early stages of growth. This chlorosis, which disappeared later in the season, was similar to the yellowing due to nitrogen deficiency. An experiment was begun in 1968, testing four rates of nitrogen, and three application timings, to determine whether lack of adequate nitrogen was the cause of the early chlorosis and if the addition of nitrogen would increase the yield of soybeans.

Previous studies

Previous nitrogen fertilization experiments by U.S.D.A. and U.C. researchers had indicated little or no yield response should be expected from the addition of nitrogen. The question raised was whether a delayed application of ammonium sulfate would allow symbiotic *Rhizobium* to form nodules and furnish some nitrogen, but still allow the soybean plants to obtain additional nitrogen at a period when use is probably high (pod set and formation of beans immediately after flowering).

The experimental plots were established on an area where inoculated soybeans had grown the two previous summers. Barley was sown in the winter of 1967 and the test was started immediately after barley harvest in 1968. The experiment was designed as a split-split plot with four replications. The remaining barley straw and stubble was burned on half of each replication, the other half was shredded with a flail type cotton stalk chopper. These areas were randomly determined for each replication. Each burned or chopped area was then divided into three equal areas and the time of fertilizer application was randomly determined. The time of application block was divided into four equal areas and the rate was randomly determined for each plot. The individual plots were 8 rows, 30 inches apart and 45 feet long.

Two times

There were two times of application, preplant and flowering, with a third treatment consisting of split applications at both times. The rates of application were 0, 50, 100, and 150 lbs of nitrogen per acre plus 0 + 0 = 0, 0 + 50 = 50, 50 + 50 = 100 and 100 + 50 = 150 for the combination preplant plus flowering treatment. The nitrogen was applied as ammonium sulfate and was chiseled into the center of the bed approximately 5 inches deep in preplant treatments; the other treatments were side dressed.

Zero N

The soybean plants on the plots with zero nitrogen showed the chlorosis noted in the previous year. The chlorosis was more pronounced on the areas where the barley straw was not burned and this contrasted sharply with the dark green appearance of the plants on the nitrogen fertilized plot. The chlorosis disappeared later in the season.

Nodulation

Pods were fully developed, still green, and leaves were beginning to turn yellow when two replications were selected for a study of nodulation on the plants in each treatment. Five plants were selected at random from each plot, carefully dug out, the roots were washed free of soil and the nodules counted. Classification of nodule size was not attempted.

The addition of 50 or more pounds per acre of nitrogen before planting lowered the production of nodules (table 1). Delayed application of up to 100 lbs of nitrogen per acre did not change the number of nodules per plant but 150 lbs per acre decreased nodulation. Rate of nitrogen application affected nodulation in a linear manner with the lower rates associated with more nodules. These differences were significant at the 1 per cent level of probability. The differences between areas where the straw was burned or not burned were not significant.

Yield

The center six rows of each plot were harvested with a small Massey-Ferguson combine. The area harvested for yield was .01 acre. Mean yields for 4 plots with the same treatment ranged from 932 lbs to 1260 lbs (Table 2) but differences due to straw burned or not burned, or rate or timing of nitrogen fertilizer were not significant.

Richard M. Hoover is Superintendent, and Associate in Agronomy, West Side Field Station, University of California, Five Points; and Benjamin H. Beard is Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Brawley, California. *This research was partially supported by a grant from the Oil Seed Crops Research Trust, Fresno, California, and co-operative agreement between the University of California and the U. S. Department of Agriculture.*